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Rediagnosis of the brittlestar genus *Ophiosyzygus* and notes on its type species *O. disacanthus* (Echinodermata: Ophiuroidea: Ophiomyxidae) based on the type specimens from Japanese waters and new material from the Gulf of Mexico

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Abstract.—Two specimens of the ophiomyxid brittlestar *Ophiosyzygus disacanthus* H. L. Clark, 1911 represent the first new record of the species since the original description. The new specimens are from the Gulf of Mexico and are conspecific with the type material from Japan. The generic diagnosis is emended to include radial shields and dorsal arm plates. Evidence is given that these types of ossicle have been overlooked frequently in ophiomyxids.

In 1911, H. L. Clark described a new monotypic genus of ophiomyxid brittlestar, *Ophiosyzygus,* based on two specimens from U.S. Fisheries Commission Steamer *Albatross* stations off the southwestern coast of Japan. Among other characters, the genus was diagnosed as lacking radial shields and dorsal arm plates. Two specimens of the type species, *O. disacanthus* H. L. Clark, 1911, were recently collected from the Gulf of Mexico off the southwestern coast of Florida, U.S.A., and they differ little from the type material. Our discovery of radial shields and dorsal arm plates in the Gulf of Mexico specimens and, subsequently, in Clark's North Pacific specimens prompts us here to emend the generic diagnosis. Examination of some museum material and a review of literature on the Ophiomyxidae indicate to us that small radial shields and thin dorsal arm plates have been overlooked often in this family.

Family Ophiomyxidae Ljungman, 1867
Subfamily Ophiomyxinae Ljungman, 1867
Genus *Ophiosyzygus* H. L. Clark, 1911

Ophiosyzygus.—Clark, 1911:275–276 (diagnosed), 279 (compared to *Ophiolepto-plax*).—Clark, 1915:172 (listed).—Fell, 1960:14 (key).—Spencer & Wright, 1966: 89 (listed in systematic review).

Diagnosis (emended).—Disc covered with skin in which are embedded, at least near margin, numerous minute delicate scales, on which are borne larger, presumably calcareous granules. Radial shields small. Tentacle scales lacking. Arm spines few, with upper ones successively united to each other by a broad, thin, horizontal membrane. Dorsal arm plates thin, simple, multiperforate. Teeth a cluster of a few, minute, rough spinelets at apex of jaw. Oral papillae small, few, and unlike teeth.

Type species.—*Ophiosyzygus disacanthus* H. L. Clark, 1911, by original designation. The genus is monotypic.

Etymology.—Given by Clark (1911), in reference to the webbing of the upper arm spines by horizontal and vertical webs of skin in dried and alcoholic specimens. Hendler & Miller (1991) found that the webbing of arm spines on dried *Ophiogeron supinus* is an artifact from desiccation of the gelatinous tissues of the arm. They were unable to induce swimming in live *O. supinus* by methods that worked successfully on four other species. These authors joined Mortensen (1932) in refuting Clark's (1911) initial implication and his (Clark 1941) later prediction that the webbed spines of ophiomyxids are used for swimming. Based on the findings of Hendler & Miller (1991), arms of *Ophiosyzygus disacanthus* in life probably are fleshy, not webbed.

Remarks.—Clark's (1911) diagnosis of the genus included the absence of radial shields and dorsal arm plates. We found both kinds of plate in the material listed below for *O. disacanthus.* Clark (1911, fig. 139a) illustrated small triangular radial shields (Fig. 1B) on *O. disacanthus,* but he described them as the "expanded ends of genital plates." Dissection of the new material from the Gulf of Mexico and re-examination of the types revealed that they indeed are radial shields, each articulating with a paired slender genital plate and genital scale (Fig. 1A). In fact, Clark's (1911) figure includes the ends of the genital plates below the misidentified radial shields (Fig. 1B). The dorsal arm plates of type and new specimens are simple multiperforate plates (Fig. 2) that are difficult to see in situ and similar to those of *Ophiodera serpentaria* (Mortensen 1933a, figs. 1, 2) and of *Ophioscolex inermis* (Mortensen 1933b, fig. 36b). Clark (1911) overlooked them, although he reported similar dorsal arm plates in *Ophioleptoplax megapora.*

Paterson (1985:18) described the Ophiomyxidae generally as having "rudimentary and inconspicuous radial shields." Equally or more rudimentary and inconspicuous in some ophiomyxids are the dorsal arm plates. Byrne & Hendler (1988) concluded that the Ophiomyxidae have a reduced skeleton in which the function of some parts has been largely assumed by mutable collagenous tissue. The loss of basic elements of the ophiuroid skeleton in some ophiomyxids might, therefore, not be surprising. Numerous genera have been diagnosed as lacking radial shields and dorsal arm plates. Subsequent examination by us and other authors has, however, confirmed the presence of radial shields or dorsal arm plates in some of these genera.

Clark (1911) mistook radial shields for the distal ends of genital plates in his new genera *Ophioleptoplax* and *Ophiocynodus* as he did in *Ophiosyzygus.* Our examination of type material (*Ophioleptoplax megapora,* USNM 25619; *Ophiocynodus corynetes,* USNM 25607) revealed his error. Koehler (1914) described *Ophioleptoplax atlantica* from a specimen that only had "traces [of its disc] left on the upper face of the arms." Koehler did not indicate the presence of radial shields; but we have found them attached to the genital plates and scales in the holotype (USNM 32304) as they appear unlabelled in Koehler's (1914) photograph (pl. 15, fig. 6) of the specimen. *Ophioscolex* was included by Fell (1960) among the ophiomyxid genera lacking radial shields, but Lyman (1882) and Paterson (1985) described them to be present, although inconspicuous, in the type species, *O. glacialis.* Verrill (1899) described as "rudimentary" the radial shields that were overlooked by Lyman (1875) in his original description of *Ophioscolex stimpsonii.*

Mortensen (1933b:314) alluded to the potential for oversight of dorsal arm plates when he wrote about *Ophioscolex inermis*: "At first glance one would rather say that dorsal plates are lacking; but . . . they are so delicate as to let the vertebrae shine through . . . ." Dorsal arm plates in many ophiomyxid species are described as small, thin,

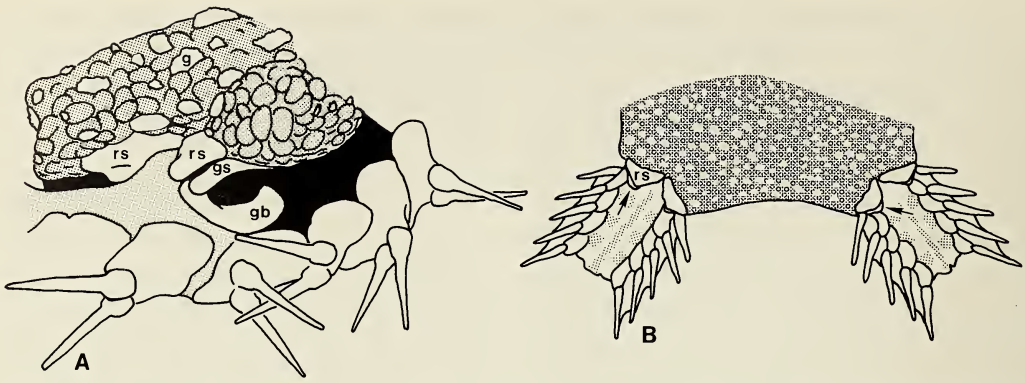

Fig. 1. *Ophiosyzygus disacanthus.* A. Paratype, oblique view of arm base, with part of ventral interradial integument removed to reveal basal five lateral arm plates with spines and the articulation of the radial shield (rs) with the genital scale (gs) and genital plate (gb). Calcareous granules (g) are shown among the dorsal scales of the disc. B. Aboral view of part of the disc and two arms (after Clark 1911, fig. 139a; probably based on the Paratype). Arrows indicate the exposed ends of the genital plates below the radial shields (rs).

multiperforate, and hyaline (Lyman 1878, 1880, 1882, 1883; Clark 1911; Koehler 1914; Matsumoto 1915; Mortensen 1933a; Fell 1960). In many cases, the plates were overlooked in earlier or later studies; and we found similar delicate plates in *Ophiocynodus corynetes,* which Clark (1911) diagnosed as lacking dorsal arm plates. Lyman's (1883) statements about the absence of dorsal arm plates in *Ophiobyrsa hystricis, Ophiobyrsa rudis,* and *Ophiobrachion uncinatus* were qualified by his reference to paired nodules or spiny tubercles over each arm joint. The purported absence of dorsal arm plates should be re-evaluated in several other ophiomyxid genera, particularly in light of the recent discovery by Hotchkiss (1993) of dorsal arm plates in the Paleozoic Oegophiurida.

It may be assumed that the small radial shields and delicate dorsal arm plates, as well as the apparent absence of either type of plate, in ophiomyxids are apomorphic reductions or losses of typically robust plates found in many other ophiuroids. Byrne & Hendler (1988; see above) gave a plausible explanation for skeletal reduction in ophiomyxids. In view of the high potential for homoplasy in reductive character states, speculation about the phylogenetic informativeness of these characters is, however, best deferred until a more complete revision of the Ophiomyxidae can be accomplished.

Ophiosyzygus disacanthus H. L. Clark, 1911
Figs. 1–2

Ophiosyzygus disacanthus Clark, 1911:18 (station list), 276–277 (described, part), fig. 139.—Clark, 1915:172 (material).—Fell, 1960:14 (listed).—Spencer & Wright, 1966:89 (listed).—Downey, 1969:183 (listing of type material, part).

Non *Ophiosyzygus disacanthus.*—Clark, 1911:277 (material, part).—Downey, 1969:183 (listing of type material, part).

Material examined.—Holotype: USNM 25671, 12 mm disc diam, *Albatross,* Sta 4934, 16 Aug 1906, 30°58′20″N, 130°32′00″E, 103–152 fm, rocky, off Sata Misaki Light, Eastern Sea, Japan.—Paratype: MCZ 3277, 8 mm disc diam, *Albatross,* Sta 4936, 16 Aug 1906, 30°54′40″N, 130°37′30″E, 103 fm, stones, off Kagoshima Gulf, Japan.

Non-type material: USNM E44353, 1 dry specimen, 5 mm disc diam, U.S. Bureau of Land Management, Southwest Florida Shelf

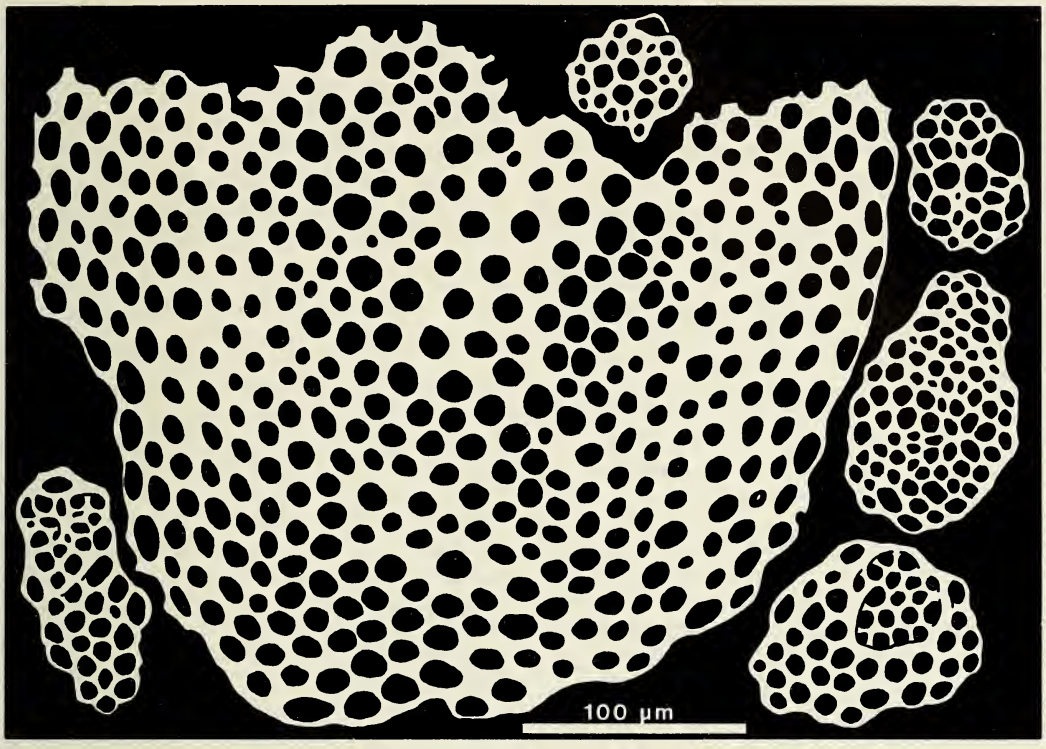

Fig. 2. *Ophiosyzygus disacanthus.* LACM 81-218.1. A large dorsal arm plate and five small plates of the ventral interradius of the disc.

Ecosystems Study, Year 2, Cruise II (BLM 321-II), Sta 35, 26 Jul 1981, 25°44.8′N, 84°21.0′W, 159 m, thin sand and rubble over rock, triangle dredge, southeastern Gulf of Mexico.—LACM 81-218.1, 1 alcoholic specimen, disc damaged, BLM 321-II, Sta 36, 3 Aug 1981, 25°16.8′N, 83°57.4′W, 127 m, deep sand with some thin sand veneer over rock.

Diagnosis.—With characters of the genus.

Description.—The two specimens from the eastern Gulf of Mexico (southwestern Florida shelf) are not a new species, for they differ from the type material only in minor ways. Arm spines are thornier, many bearing two rows of two or three subapical teeth on opposite sides of the shaft. Fewer arm spines on the type specimens are thorny, and they bear fewer teeth (one or two per row). There are generally three oral papillae per row on the jaws, but the number is highly variable within specimens (Japan specimens, 2–4; Florida, 2–5). The integument also includes white, opaque, irregular granules (Fig. 1) that reach and extend above the surface and appear like icebergs. The granules look imperforate, lacking the typical stereomal-stromal organization of echinoderm ossicles. The granules probably are not calcitic ossicles, for they disaggregate in sodium hypochlorite and do not effervesce in weak acid. Granules of the two specimens from Florida are smaller (84 ± 21.9 µm, n = 9; 124 ± 32.8 µm, n = 10) than those of the holotype (232 ± 67.8 µm, n = 34) and paratype (221 ± 53.8 µm, n = 21). Considering the poor condition of the types and new specimens, more rigorous comparisons must await the availability of better material.

Flat, multiperforate plates 111 ± 22 µm (n = 24) in diameter are embedded deep in

the skin of the ventral interradius of the disc (Fig. 2). They are visible in the type specimens without treatment with sodium hypochlorite and were probably overlooked by Clark (1911), who wrote that the ventral interradius is naked.

Five measurable, prolately spheroidal eggs out of seven removed from an ovary of one specimen (LACM 81-218.1) ranged in greatest diameter from 100 μm to 140 μm. Ossicles of the gonadal wall are irregular perforate plates.

Type locality.—Off the southern coast of Kyushu, Japan.

Distribution.—Japan; eastern Gulf of Mexico.

Habitat.—Type specimens were taken from rocky and stony substrata at 188–278 m in the Pacific Ocean. Stations from which specimens were collected in the eastern Gulf of Mexico at 127–159 m were described by Woodward-Clyde Consultants & Continental Shelf Associates, Inc. (1985). At both stations in the Gulf of Mexico, the bottom was gently sloping, rarely with outcrops of rock or other relief, and mostly covered with a veneer of sand over hard substratum (Station 35) or with deep sand (Station 36). The most diverse benthic taxa in descending order at Station 35 were cnidarians, echinoderms, sponges, and crustaceans; and at Station 36, crustaceans, cnidarians, echinoderms, and sponges. A green encrusting alga dominated the epibenthic cover at Station 35. At Station 36, cover was dominated by sponges in summer and by crinoids in winter.

Etymology.—Given by Clark (1911), in reference to the paired arm spines.

Remarks.—In his original description of *O. disacanthus,* Clark (1911) was uncertain of the identity of one paratype (USNM 26217), which lacked a disc. The specimen clearly is not *O. disacanthus.* Although distal arm spines are glassy and terete, proximal arm spines are flattened, robust, and obtuse, and they do not appear glassy. Most arm segments bear three arm spines, rarely four, and only a few proximal segments bear the two that are the typical number for *O. disacanthus.* Upper arm spines are not webbed. Much of the oral structure is obscured by mud, but the jaws can be seen to carry a vertical row of 3–6 teeth (one jaw has none), an apical cluster of tooth papillae, and 4–8 spiniform oral papillae.

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